

# OPTIMIZATION INITIATIVES FOR A LONG-RUNNING GROUNDWATER PUMP & TREAT SYSTEM, (FORMER) NAVAL INDUSTRIAL RESERVE ORDNANCE PLANT, FRIDLEY, MN

Presented by

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## Objective of Presentation



Present interim results of several ongoing optimization initiatives focused on:

- Short- and long-term improvement in operation of groundwater treatment facility
- Optimization of a long-term groundwater monitoring program
- Evaluation of passive groundwater sampling method

## Optimization of Operation of Groundwater Treatment Facility

Navy constructed a groundwater treatment facility (GWTF) in 1992 'to capture and contain" a VOC plume

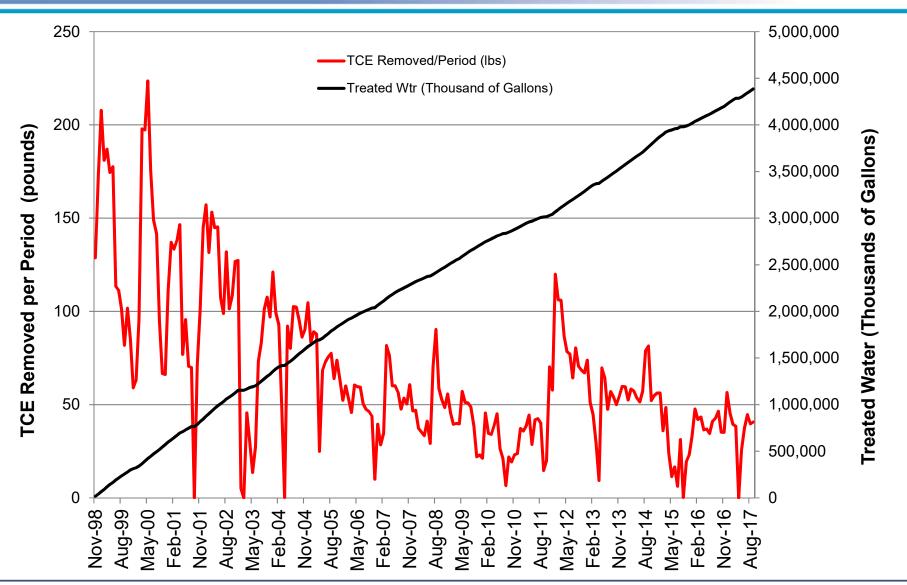


Main Treatment Area ASUs

- GWTF runs 24/7 and treats an average of ~ 16 million gallons per month. Cumulative TCE mass removed through December 2017 is ~41,100 lbs.
- Navy sold property in 2004 and 122 acre site is undergoing \$100M redevelopment as a commercial warehousing center
- Current GWTF and extraction wells are in need of a re-build planned construction during FY 2022
- Access to source areas for treatment is limited by new construction

### **GWTF Performance Curves**



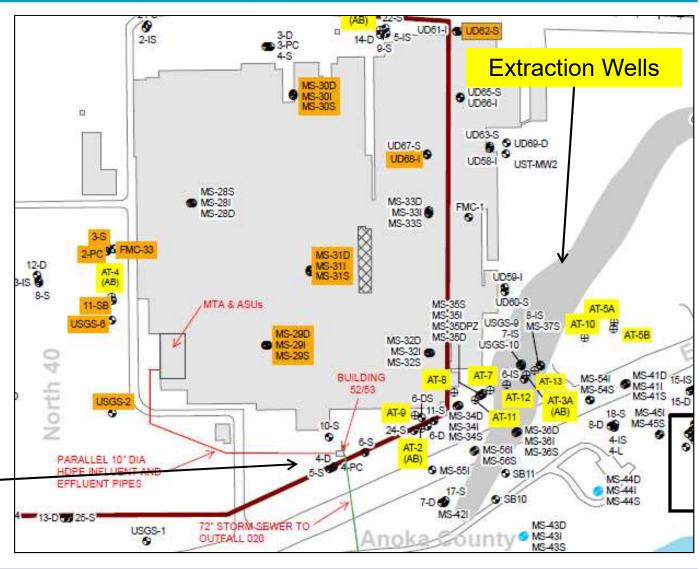


## GWTF - Current Extracted / Treated Water Flow Path



- Groundwater is pumped from extraction wells to Bldg. 52/53 equalization tank
- Pumped to Main Treatment Area inside BAE building
- 3. Pumped to Outfall 020 to Miss. River





### Optimization Review of GWTF Plant



Objective: Review of GWTF mechanical systems and operation for improvement (short-and long-term):

- ✓ Evaluation yielded eight minor, six moderate, and two major cost improvements
- ✓ Findings indicated one air stripper unit (ASU) could be taken off line due to reduced influent TCE concentration

Blower Operating Costs NIROP, FRIDLEY, MINNESOTA						
Number of Air Strippers Operating	4	3	2			
Monthly kWh	53,260	39,945	26,630			
Monthly Costs	\$6,391	\$4,793	\$3,196			
Annual Cost	\$76,700	\$57,500	\$38,300			
Cost Savings over 4 units operating	NA	\$19,200	\$38,400			

✓ Major improvement recommendations:

Plant should be re-built at a new location to:

- place GWTF outflow near discharge to maximize gravity flow (fewer pumps)
- shorten pumping distance from extraction wells to GWTF plant
- allow for conversion to smaller, easier-maintained ASUs

## Optimization of Monitoring Well Network



Objective: to refine/reduce number of wells sampled annually (~100) to match Navy's obligation to assess plume status

Site conditions driving well network optimization:

- ➤ It was time site investigation phase over and plume is stable
- ➤ 100+ wells for 83 acre site?! (this is too many for a mature site in RA-O phase)
- Site developer was abandoning Navy wells during construction (committed to one-for-one replacement well at Navy designated locations)
- Confidence in plume shape and COC concentration trend based on many years of annual sampling of groundwater

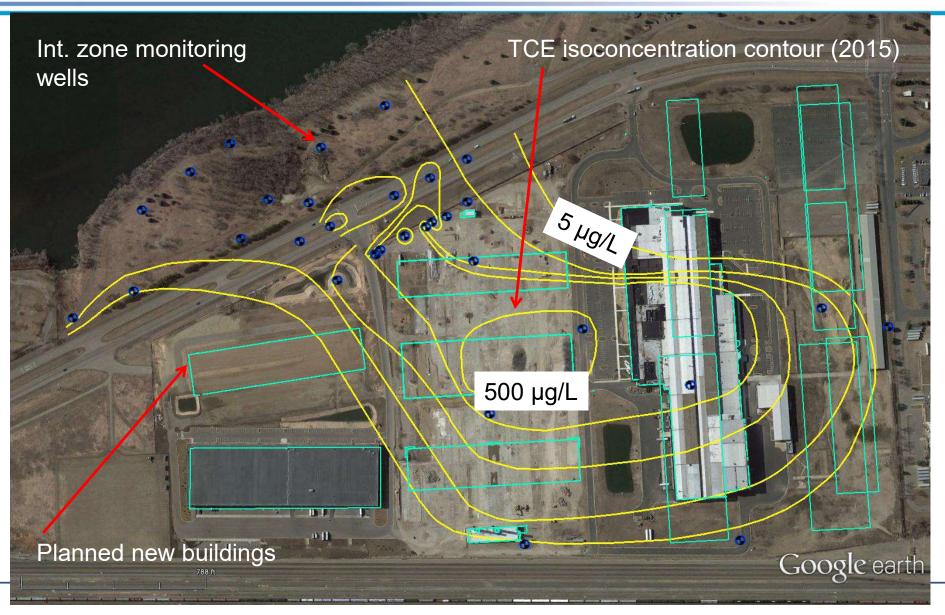
## Screening Process and Tools for Evaluation



- Has well been sampled on a routine schedule?
- What data does a sampled well provide ? (frequency of detection, avg. conc., conc. range, etc.)
- Where is well located relative to plume delineation and assessment of contain/capture analysis? (i.e., well 'value')
- How sufficient is the number of wells per aquifer interval? (shallow, intermediate, deep, bedrock)
- What is the COC trend per well? (Mann-Kendall determination of increasing/decreasing/no trend)
- What are the regulators primary concerns/preferences relative to annual monitoring?

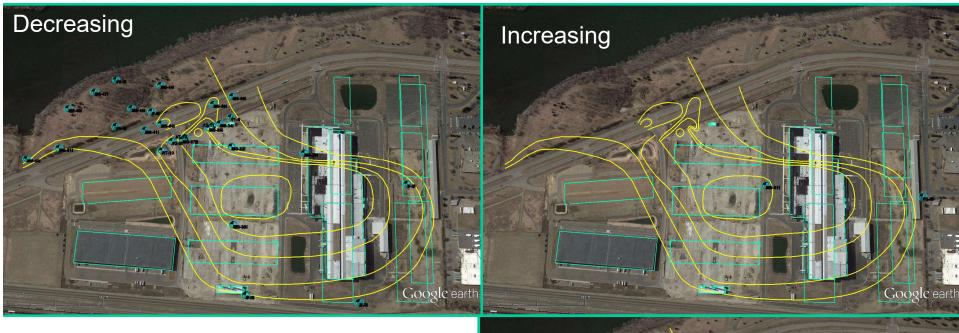
## Example Map – 2015 Intermediate Zone Monitoring Wells and TCE Plume





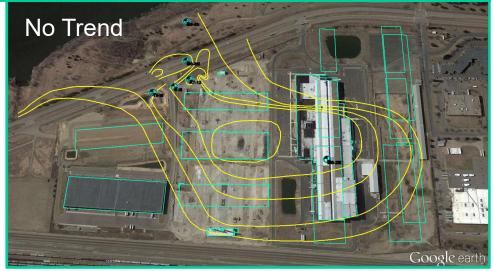
## Example – Summary of Mann-Kendal Trend (2001-14)





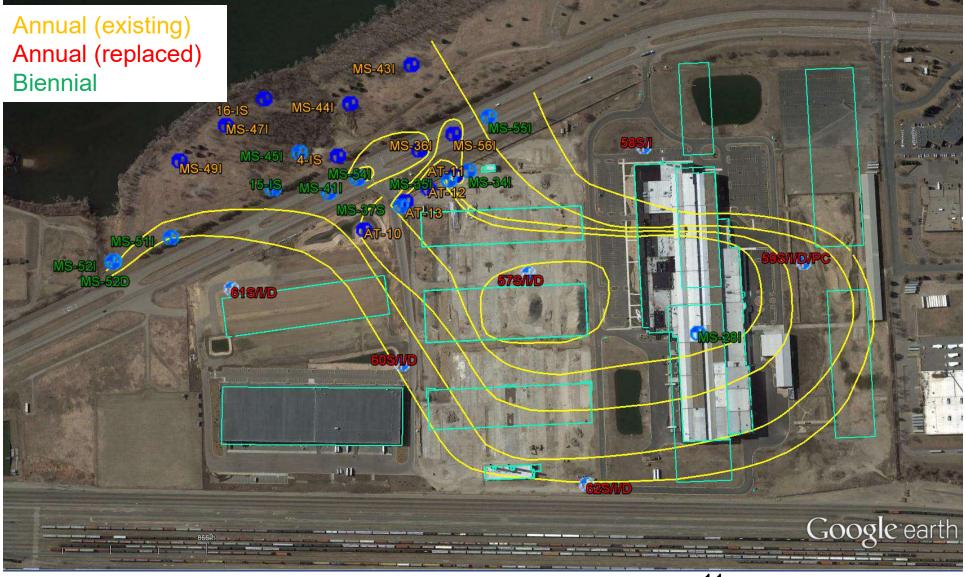
Used Mann-Kendall statistical analysis to show:

- 29 wells with a decreasing TCE trend
- 2 wells with an increasing trend
- 8 wells with no defined trend



## Optimized Intermediate Wells - Annual & Biennial Sampling

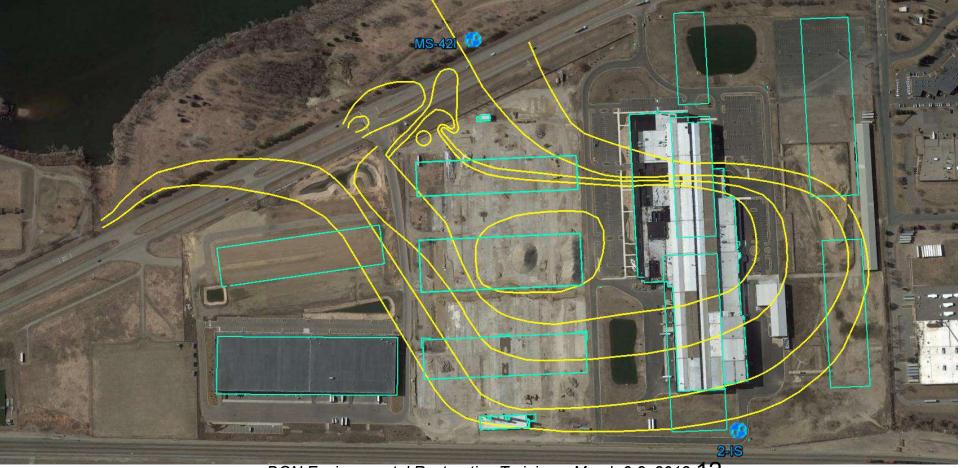








Location	Current Sampling Frequency	MAROS Trend Analysis Result	MONITORING RECOMMENDAT IONS	OPTIMIZATION RATIONALE
2-IS	Annual	Downward Trend	Five Year	Upgradient, decreasing trend, low concentrations
MS-42I	Annual	Downward Trend	I - IVA VA2r	Redundant location with 17-S, plume edge, low concentrations. Redundant location warrants sampling at Five-Year Review.



## Optimized Sampling Design



Monitored Interval	Previous Sample Design	Optimized Sampling Design		
	2015	Annual	Biennial	Five Year
Shallow	34	19	12	5
Intermediate	29	18	11	2
Deep & Bedrock	29	12	13	4
Yearly Total	92	49	36	11
% Reduction vs. 2015		47%	61%	87%

## Take Aways – Well Network Optimization



- Assess if site monitoring program needs tweaking (are too many wells sampled for site area & for meeting monitoring objective?)
- Need enough data to assess trends and each well's value (i.e., is next year sample results likely to be the same as past years?)
- Keep the statistical analysis simple use one technique (e.g., MAROS)
- Negotiate and compromise if needed (e.g., retain a well for water level measurement but drop from sampling plan)
- Retain key wells needed for Five Year Review sampling
- Follow up optimization with well abandonment actions
- Final optimization design may require a workshop meeting with regulators to resolve differences

## Optimization of GW Sampling – Use of Passive Sampling Method



Objective: To evaluate use of lower cost passive sampling method for annual groundwater monitoring

Screening Process and Tools Used:

- ✓ RITS presentation provided key concepts to evaluate change in sampling
- ✓ CLEAN contractor performed desktop study of available technologies/devices to perform passive sampling
- ✓ Previous USGS study of passive diffusion bags indicated comparable results
- ✓ NIROP Fridley COC list is constrained to VOCs

## Benefits of Passive Sampling Devices



- Majority of sampling devices are disposable, eliminating potential crosscontamination
- ➤ Relatively easy to deploy and recover (most require a 2 week equilibrium period between deployment and recovery)
- Can be deployed in most wells (even damaged wells or obstructed wells)
- Minimal disturbance of water column upon deployment
- Can sample discrete intervals within a well (deployed in a series for vertical contamination profile) & no depth limits
- Most samplers are not subject to interference from turbidity
- Monitoring of stabilization parameters not required
- No purging of well required; therefore no associated disposal cost
- Water sample is representative of formation water
- ➤ Low initial cost / capital investment
- Decrease in field labor and overall sampling event duration

## Limits of Passive Sampling Devices



- Device must be fully submerged within screened interval during deployment
- Improper placement can result in significant concentration differences
- Requires the aquifer to be in hydraulic communication with the screened portion of the well
- Collection of water chemistry parameters (if required) would add a separate sampling step
- Some devices may have volume/analyte limitations
- Requires consideration of contaminant stratification

### Sampling Devices





#### **GORE Module**

Diffusion and sorption via membrane to accumulate on absorbent



#### Regenerated-Cellulose Dialysis Membrane Sampler

Deionized water-filled bag, suspend in well to equilibrate then recover



#### HydraSleeve

Grab sampler, deployed to stabilize, pull to open and collect sample



#### Rigid Porous Polyethylene Sampler

Diffusion through waterfilled pores to equilibrate then recover



#### **Snap Sampler**

Grab sampler, deployed to depth, trigged to close and retrieved. Bottle sent to lab.



## Passive Diffusion Bag Sampler

Deionized water-filled bag, suspend in well to equilibrate then recover

#### **Cost Reduction**



Passive groundwater sampling techniques typically provide a much lower "per sample" cost than conventional low-flow sampling methods

- Reduction in labor hours
- Elimination of costs associated with handling and disposal of purge water

Overall cost comparison between passive and low-flow techniques

- Passive Samplers
  - >99.75% of the total LTM cost is associated with sample collection
    - ■15% towards sample collection (labor)
    - ■85% towards cost of sampling device
- Low-flow Sampling
  - ▶45% of the total LTM cost is associated with sample collection
    - ■93% towards sample collection (labor)
    - ■7% towards sampling equipment (pumps and meters)

## **Cost Comparison**



Device/Method	Overall Cost Per Sampling Event	Estimated Sampling Days
Gore Module (1)	\$41,475	7
Hydra Sleeve	\$37,620	8
Snap Sampler	\$41,870	10
Regenerated-Cellulose Dialysis Membrane	\$42,900	8
Rigid, porous, polyethylene	\$41,060	8
Passive diffusion bag	\$38,760	8
Low Flow Sampling	\$91,060	12

<sup>&</sup>lt;sup>1</sup> – cost for Gore Module includes VOC analysis

## **Key Considerations**



- Comparable results PDB sample analytical results must be similar to historic sampling results using low flow sampling method
- Regulatory acceptance USEPA typically acceptive of passive sampling as long as site hydrology is well understood
- Most States require some sort of comparative study if passive samplers are intended to replace existing sampling technique
- Low-flow sampling yields water that may be representative of the entire length of the screen due to mixing; whereas, passive sampling yields water from a discrete location within this interval
- Side-by-side field test comparing PDB sampling to low-flow sampling was previously conducted at NIROP Fridley in 1999 (19 wells):
  - ➤ Test results showed a good agreement in several wells between the two sampling techniques, but also showed a poor agreement in others
  - ➤ It was concluded that the data from the PDB samplers accurately reflected the VOC concentrations in the screened interval of the well; whereas, the data from the low-flow sampling reflected VOC concentrations from the entire well due to mixing during pumping

## Take Aways – Use of Passive Sampling Approach



- Represents a lower cost approach to routine, repetitive sampling for groundwater monitoring programs with established COCs and sufficient data for comparison
- Will likely require a comparability study to prove to regulators that new technique provides data similar to historic data
- May be applicable to only a subset of wells
- Draft PDB Sampling and Analysis Plan to be submitted to US EPA Region 5 and Minnesota Pollution Control Agency for review

### Supplemental Information



NAVFAC EXWC 2013 – *Transitioning From Conventional to Passive Sampling for Groundwater* (April)

Tetra Tech 2017 - Technical Memorandum Alternative Sampling Methodologies, Operable Unit 1, Naval Industrial Reserve Ordnance Plant, Fridley, MN (January)

RITS 2016 (Dr. E. Cohen, Arcadis) – Passive Groundwater Sampling: Effective Tools to Transition Your Program

### **Contact and Questions**



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#### **Questions?**